In re Patent Application of:
**ISAKSSON ET AL.**
Serial No. **09/147,750**
Filed: **MAY 28, 1999**
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**In the Claims:**

1. (Previously Amended) A multi-carrier transmission system comprising a first and a second transceiver, each of said transceivers having a receiver and a transmitter, wherein data is transmitted between said transceivers by modulating said data onto a multiplicity of carrier waves in the form of multi-bit symbols, wherein each carrier wave constitutes a channel, and wherein the number of bits per symbol, (the bit loading), varies between channels and, within a channel, with time, so that each channel has associated therewith a bit loading parameter, characterized in that, in operation, said multi-carrier system is adapted to synchronously update, at said first and second transceivers, the bit loading parameters associated with each channel by transmission of data over a control channel, in that said control channel is established, at system start-up, on a predetermined one of said multiplicity of carrier waves whose identity is known to said first and second transceivers, and in that said control channel is, after start-up, changed from said predetermined channel to a further channel, selected by said first transceiver on the basis of channel characteristics.

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2. (Previously Amended) A multi-carrier transmission system, as claimed in claim 1, characterized in that decisions relating to changes in bit loading and control channel selection are initiated by said first transceiver transmitting command signals over said control channel, in that said second transceiver effects changes in bit loading and control channel carrier wave selection, and in that said second transceiver

measures changes in channel characteristics and forwards data relating thereto over said control channel to said first transceiver.

3. (Previously Amended) A multi-carrier transmission system, as claimed in claim 1, characterized in that said multi-carrier transmission system is a DMT transmission system.

4. (Previously Amended) A multi-carrier transmission system, as claimed in claim 1, characterized in that said multicarrier transmission system is a DMT-based VDSL system.

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5. (Previously Amended) A multi-carrier transmission system, as claimed in claim 1, characterized in that said multicarrier transmission system is a DMT-based ADSL system.

6. (Previously Amended) A multi-carrier transmission system, as claimed in claim 3, characterized in that said predetermined carrier wave is selected from said multiplicity of carrier waves on the basis of channel SNR characteristics so that said control channel is subject to minimal interference from noise.

7. (Previously Amended) A multi-carrier transmission system, as claimed in claim 1, characterized in that, on activation of said multi-carrier system, said control channel is established by a process comprising the following three steps:

establishing said control channel on a predetermined carrier wave;

transferring said control channel to a carrier wave selected by said multi-carrier system and enabling bit loading control; and

enabling of all carrier waves.

8. (Previously Amended) A multi-carrier transmission system, as claimed in claim 7, characterized in that said step of establishing said control channel includes, in each of said first and second transceivers:

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booting said transmitter;

said transmitter continuously transmitting frames in which all carrier waves other than said predetermined wave are modulated with random data;

said transmitter transmitting a system heartbeat;

booting said receiver;

said receiver initiating channel equalization and synchronizing clocks in said first and second transceivers; and

establishing said control channel on said predetermined carrier wave on receipt of a heartbeat.

9. (Previously Amended) A multi-carrier system, as claimed in claim 8, characterized in that said step of

transferring said control channel includes, in said first transceiver:

receiving data, by the transmitter, relating to measured channel characteristics from receivers in both said first and second transceivers;

selecting a carrier wave to which said control channel is to be reallocated by said transmitter;

transmitting, by said transmitter, a signal identifying said carrier wave, to which said control channel is to be reallocated, to said second transceiver;

on receipt of a confirmation signal, from said second transceiver, said transmitter terminating said control channel on said predetermined carrier wave;

said transmitter starting said control channel on the reallocated carrier wave at a heartbeat;

said receiver measuring channel characteristics and transmitting data relating thereto to said transmitter in said first transceiver;

said receiver equalizing said measured channel;

said receiver obtaining a channel estimation from the second transceiver and transmitting data relating thereto to said transmitter in said first transceiver;

said receiver receiving data identifying the carrier wave for reallocation of said control channel;

said receiver receiving a confirmation signal from said second transceiver;

said receiver terminating the control channel on said predetermined carrier wave;

said receiver establishing the control channel on the reallocated carrier wave; and

if said control channel cannot be established, returning to said step of establishing said control channel.

10. (Previously Amended) A multi-carrier system as claimed in claim 7, characterized in that said step of enabling all carrier waves includes, on a continuous basis, in said first transceiver:

said transmitter obtaining data relating to measured channels from receivers in both said transceivers;

said transmitter determining the bit loading parameter for each carrier wave;

said transmitter transmitting data relating to the bit loading parameter to said second transceiver;

said transmitter changing the bit loading parameter on confirmation from said second transceiver;

the receiver measuring the channel characteristics of said multiplicity of channels and sending data relating to said measurements to said transmitter;

the receiver equalizing said multiplicity of channels in accordance with said measured channel characteristics;

the receiver obtaining a channel estimation from said second transceiver for each of said multiplicity of channels;

the receiver obtaining a new bit loading parameter for each of said multiplicity of channels;

the receiver obtaining a confirmation signal from said second transceiver;

the receiver updating the bit loading parameters for each of the multiplicity of channels.

11. (Previously Amended) A multi-carrier transmission system, as claimed in claim 1, characterized in that channel characteristics are estimated by periodic transmission, by one of said transceivers, of a base sync frame having a predetermined content and comparing, in the other of said transceivers, the received base sync frame with a reference frame.

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12. (Previously Amended) A multi-carrier transmission system, as claimed in claim 11, characterized in that said channel characteristics include attenuation, phase shifting and variance.

13. (Previously Amended) A multi-carrier transmission system, as claimed in claim 11, characterized in that said base sync frames are transmitted at base sync intervals (BSI), and said BSI is locked into said transceivers thereby enabling said transceivers to identify a frame as a sync frame.

14. (Previously Amended) A multi-carrier transmission system, as claimed in claim 13, characterized in that additional sync frames are transmitted at intervals between said base sync frames.

15. (Previously Amended) A multi-carrier transmission system, as claimed in claim 13, characterized in that said first transceiver issues commands for system reconfiguration at the start of the BSI, and in that system reconfiguration is effected at the start of the next BSI.

16. (Previously Amended) A multi-carrier transmission system, as claimed in claim 13, characterized in that said BSI is greater than twice a system transit time for the multi-carrier transmission system.

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17. (Previously Amended) In a multi-carrier transmission system having a first and a second transceiver, each of said transceivers having a receiver and a transmitter, wherein data is transmitted between said transceivers by modulating said data onto a multiplicity of carrier waves in the form of multi-bit symbols, wherein each of said carrier waves constitutes a channel, and wherein the number of bits per symbol, (the bit loading), varies between channels and, within a channel, with time, so that each channel has associated therewith a bit loading parameter, a method of operating a control channel characterized by:

synchronously updating, at said first and second transceivers, the bit loading parameters associated with each channel by transmission of data over the control channel;

establishing said control channel, at system start-up, on a predetermined one of said multiplicity of carrier waves

whose identity is known to said first and second transceivers; and

after start-up, changing said control channel from said predetermined channel to a further channel, selected by said first transceiver on the basis of channel characteristics.

18. (Previously Amended) A method, as claimed in claim 17, characterized by:

initiating decisions, relating to changes in bit loading and control channel selection, in said first transceiver and transmitting command signals over said control channel;

effecting changes in bit loading and control channel carrier wave selection in said second transceiver; and

in said second transceiver, measuring changes in channel characteristics and forwarding data relating thereto over said control channel to said first transceiver.

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19. (Previously Amended) A method, as claimed in claim 17, characterized in that said multi-carrier transmission system is a DMT transmission system.

20. (Previously Amended) A method, as claimed in claim 17, characterized in that said multi-carrier transmission system is a DMT-based VDSL system.

21. (Previously Amended) A method, as claimed in claim 17, characterized in that said multi-carrier transmission system is a DMT-based ADSL system.

22. (Previously Amended) A method, as claimed in claim 19, characterized by selecting said predetermined carrier wave from said multiplicity of carrier waves on the basis of channel SNR characteristics so that said control channel is subject to minimal interference from noise.

23. (Previously Amended) A method, as claimed in claim 17, characterized by establishing said control channel, on activation of said multi-carrier system, by a process comprising the following three steps:

establishing said control channel on a predetermined carrier wave;

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transferring said control channel to a carrier wave selected by said multi-carrier system and enabling bit loading control; and

enabling all carrier waves.

24. (Previously Amended) A method, as claimed in claim 23, characterized by said step of establishing said control channel including, in each of said first and second transceivers:

booting said transmitter;

said transmitter continuously transmitting frames in which all carrier waves other than said predetermined wave are modulated with random data;

said transmitter transmitting a system heartbeat;

booting said receiver;

said receiver initiating channel equalization; synchronizing clocks in said first and second transceivers; and

establishing said control channel on said predetermined carrier wave on receipt of a heartbeat.

25. (Previously Amended) A method, as claimed in claim 24, characterized by said step of transferring said control channel including, in said first transceiver:

receiving data, by the transmitter, relating to measured channel characteristics from receivers in both said first and second transceivers;

selecting a carrier wave to which said control channel is to be reallocated by said transmitter;

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transmitting, by said transmitter, a signal identifying said carrier wave, to which said control channel is to be reallocated, to said second transceiver;

on receipt of a confirmation signal, from said second transceiver, said transmitter terminating said control channel on said predetermined carrier wave;

said transmitter starting said control channel on the reallocated carrier wave at a heartbeat;

said receiver measuring channel characteristics and transmitting data relating thereto to said transmitter in said first transceiver;

said receiver equalizing said measured channel; said receiver obtaining a channel estimation from the second transceiver and transmitting data relating thereto to said transmitter in said first transceiver;

said receiver receiving data identifying the carrier wave for reallocation of said control channel;

said receiver receiving a confirmation signal from said second transceiver;

said receiver terminating the control channel on said predetermined carrier wave;

said receiver establishing the control channel on the reallocated carrier wave; and

if said control channel cannot be established, returning to said step of establishing said control channel.

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26. (Previously Amended) A method, as claimed in claim 23, characterized by said step of enabling all carrier waves including, on a continuous basis, in said first transceiver:

said transmitter obtaining data relating to measured channels from receivers in both said transceivers;

said transmitter determining the bit loading parameter for each carrier wave;

said transmitter transmitting data relating to the bit loading parameter to said second transceiver;

said transmitter changing the bit loading parameter on confirmation from said second transceiver;

the receiver measuring the channel characteristics of said multiplicity of channels and sending data relating to said measurements to said transmitter;

the receiver equalizing said multiplicity of channels in accordance with said measured channel characteristics;

the receiver obtaining a channel estimation from said second transceiver for each of said multiplicity of channels;

the receiver obtaining a new bit loading parameter for each of said multiplicity of channels;

the receiver obtaining a confirmation signal from said second transceiver;

the receiver updating the bit loading parameters for each of the multiplicity of channels.

27. (Previously Amended) A method, as claimed in claim 17, characterized by estimating channel characteristics by periodic transmission, by one of said transceivers, of a base sync frame having a predetermined content and comparing, in the other of said transceivers, the received sync frame with a reference frame.

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28. (Previously Amended) A method, as claimed in claim 27, characterized by said channel characteristics including attenuation, phase shifting and variance.

29. (Previously Amended) A method, as claimed in claim 27, characterized by transmitting said base sync frames at base sync intervals (BSI), and locking said BSI into said transceivers thereby enabling said transceivers to identify a frame as a sync frame.

30. (Previously Amended) A method, as claimed in claim 29, characterized by transmitting additional sync frames at intervals between said base sync frames.

31. (Previously Amended) A method, as claimed in claim 29, characterized by said first transceiver issuing commands for system reconfiguration at the start of the BSI and effecting system reconfiguration at the start of the next BSI.

32. (Previously Amended) A method, as claimed in claim 29, characterized in that said BSI is greater than twice a system transit time for the multi-carrier transmission system.

Claims 33-35 (Previously Canceled).

36. (Currently Amended) A multi-carrier transmission system comprising:

first and second transceivers each having a receiver and a transmitter, wherein data is transmitted between said transceivers by modulating the data onto a ~~multiplicity~~ plurality of carrier waves in the form of multi-bit symbols, wherein each carrier wave defines a channel, and wherein the number of bits per symbol varies ~~between channels and, within a channel, with time,~~ so that each channel has associated therewith a bit loading parameter;

the first and second transceivers synchronously updating the bit loading parameters associated with each channel by transmission of data over a control channel, wherein the

control channel is established, at system start-up, on a predetermined one of the ~~multiplicity~~ plurality of carrier waves which is known to the first and second transceivers, and the control channel is, after start-up, changed from the predetermined channel to a different ~~further channel,~~ channel based upon ~~selected by the first transceiver on the basis of channel characteristics.~~ characteristics of the channel.

37. (Previously Added) A multi-carrier transmission system, as claimed in claim 36, wherein decisions relating to changes in bit loading and control channel selection are initiated by the first transceiver transmitting command signals over the control channel, wherein the second transceiver effects changes in bit loading and control channel carrier wave selection, and wherein the second transceiver measures changes in channel characteristics and forwards data relating thereto over the control channel to the first transceiver.

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38. (Previously Added) A multi-carrier transmission system, as claimed in claim 36, wherein the multi-carrier transmission system is a DMT transmission system.

39. (Previously Added) A multi-carrier transmission system, as claimed in claim 36, wherein the multicarrier transmission system is a DMT-based VDSL system.

40. (Previously Added) A multi-carrier transmission system, as claimed in claim 36, wherein the multicarrier transmission system is a DMT-based ADSL system.

41. (Currently Amended) A method of operating a control channel in a multi-carrier transmission system having a plurality of transceivers, the method comprising:

transmitting data between the transceivers by modulating the data onto a ~~multiplicity~~ plurality of carrier waves in the form of multi-bit symbols, each of the carrier waves defining a channel, and the number of bits per symbol varies ~~between channels and, within a channel, with time,~~ so that each channel has associated therewith a bit loading parameter;

synchronously updating, at the transceivers, the bit loading parameters associated with each channel by transmission of data over the control channel;

establishing the control channel, at system start-up, on a predetermined one of the ~~multiplicity~~ plurality of carrier waves whose identity is known to the transceivers; and

after start-up, changing the control channel from the predetermined channel to a different ~~further channel,~~ channel based upon ~~selected by one of the transceivers on the basis of channel characteristics.~~ characteristics of the channel.

42. (Previously Added) A method, as claimed in claim 41, further comprising:

initiating decisions, relating to changes in bit loading and control channel selection, in the one transceiver and transmitting command signals over the control channel;

effecting changes in bit loading and control channel carrier wave selection in another transceiver; and

in the another transceiver, measuring changes in channel characteristics and forwarding data relating thereto over the control channel to the one transceiver.

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43. (Previously Added) A method, as claimed in claim 41, wherein the multi-carrier transmission system is a DMT transmission system.

44. (Previously Added) A method, as claimed in claim 41, wherein the multi-carrier transmission system is a DMT-based VDSL system.

45. (Previously Added) A method, as claimed in claim 41, characterised in that said multi-carrier transmission system is a DMT-based ADSL system.